IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: STEARNS et al. | Attorney Docket No.: XENOP009

Patent: 7,616,985 B2 | Issued: November 10, 2009

Title: METHOD AND APPARATUS FOR 3-D IMAGING OF INTERNAL LIGHT SOURCES | Confirmation No.: 6444

CERTIFICATE OF EFS-WEB TRANSMISSION
I hereby certify that this correspondence is being transmitted electronically through EFS-WEB to the Commissioner for Patents, P.O. Box 1450 Alexandria, VA 22313-1450 on **June 22, 2010**.

Signed: /Lydie Fitzsimmons/
Lydie Fitzsimmons

REQUEST FOR CERTIFICATE OF CORRECTION OF OFFICE MISTAKE (35 U.S.C. §254, 37 CFR §1.322)

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450
Attn: **Certificate of Correction**

Dear Sir:

Attached is Form PTO-1050 (Certificate of Correction) at least one copy of which is suitable for printing. The errors together with the exact page and line number where the errors are shown correctly in the application file are as follows:

<u>In the Specification:</u>

Col. 14, line 51, change "mediuminside" to --medium inside--. This appears correctly in the specification as filed on page 22, line 12.

<u>CLAIMS:</u>

Col. 22, line 13, (Claim 1), change "tree-dimensional" to --three-dimensional--. This appears correctly in the Amendment filed July 24, 2009, page 2, line 1, (claim 1).

Patentee hereby requests expedited issuance of the Certificate of Correction because the error lies with the Office and because the error is clearly disclosed in the records of the Office. As required for expedited issuance, enclosed is documentation that unequivocally supports the patentee's assertion without needing reference to the patent file wrapper.

It is noted that the above-identified errors were printing errors that apparently occurred during the printing process. Accordingly, it is believed that no fees are due in connection with the filing of this Request for Certificate of Correction. However, if it is determined that any fees are due, the Commissioner is hereby authorized to charge such fees to Deposit Account 50-4481 (Order No. XENOP009)

Respectfully submitted,
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volume element size may be about 1 cm^3, and the final volume element size for volume elements close to the source may reduce to about $8*10^{-3}$ cm^3.

Process flow 540 then establishes a relationship between the surface elements and volume elements (544). In one embodiment, the reconstruction method uses a linear relationship between the source emission strength and the photon density at the surface. In a specific embodiment, the linear relationship is described by a Green's function. The Green's function contains all of the information about the transport of photons inside the sample, including the effects of inhomogeneities in the volume and internal reflection at the boundary. The Green's function describes the transport of photons inside the sample from each point in the source distribution to the inside of each surface element of the sample.

When the medium inside the sample is assumed or modeled as homogeneous, one useful form for the Green's function is a simplified approximation in which the surface of the sample is treated locally as a planar interface oriented perpendicular to a line connecting a volume element center and a surface element. The photon density at the surface is the analytical solution for a point source in a semi-infinite slab using the partial-current boundary condition. Since the solution is only a function of the distance between the volume element and the surface, the simplified Green's function can be calculated for all pairs of volume elements and surface vertices with minimal computational expense.

With a linear relationship between the source strength in each volume element and the photon density at each surface element described by a Green's function G_{ij}, the photon density at the jth surface element may be approximated by the sum of the contributions from all the volume elements:

$$\rho_j \cong \sum_i G_{ij} S_i \qquad (4)$$

where the index i enumerates the volume elements and S_i is the value of the strength of the point source (photons/sec) inside the ith volume element.

Light transport in turbid media such as tissue is dominated by scattering and is essentially diffusive in nature. The condition for diffusive transport is that the scattering

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: STEARNS et al.	Attorney Docket No.: XENOP009
Application No.: 10/606,976	Examiner: Gupta, Vani
Filed: June 25, 2003	Art Unit: 3768
Title: METHOD AND APPARATUS FOR 3-D IMAGING OF INTERNAL LIGHT SOURCES	Confirmation No.: 6444

CERTIFICATE OF EFS-WEB TRANSMISSION
I hereby certify that this correspondence is being transmitted electronically through EFS-WEB to the Commissioner for Patents, P.O. Box 1450 Alexandria, VA 22313-1450 on **July 24, 2009**.

Signed: / Michelle Pascual /
Michelle Pascual

RESPONSE TO FINAL OFFICE ACTION OF MAY 7, 2009

Mail Stop **AF**
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the Final Office Action dated May 7, 2009, the period of response for which extends through August 7, 2009, please amend the above-identified patent application and consider the accompanying remarks.

Amendments to the claims are reflected in the Listing of Claims, which begin on page 2 of this paper. This Listing of Claims will replace all prior versions, and listings, of claims in the application:

Remarks begin on page 8 of this paper.

LISTING OF CLAIMS:

1. (Currently Amended) A method for obtaining a three-dimensional representation of a light source distribution located inside a mammal, the method comprising:

obtaining a topographical surface representation of the mammal; ~~and~~

providing surface light image data from light emitted from a surface of the mammal originating from the light source distribution located inside the mammal; and

using a processing system, reconstructing a three-dimensional representation of the light source distribution internal to the mammal using the topographical surface representation and the surface light emission data.

2. (Canceled)

3. (Previously Presented) The method of claim 1 further comprising dividing the topographical surface representation into a set of surface elements.

4. (Original) The method of claim 3 wherein each surface element is approximated as planar.

5. (Previously Presented) The method of claim 3 further comprising creating a set of volume elements within the mammal.

6. (Original) The method of claim 5 wherein each volume element is modeled to contain a point light source at its center.

7. (Original) The method of claim 6 wherein the three-dimensional representation of the light source distribution is approximated by a set of point light sources.

8. (Previously Presented) The method of claim 5 further comprising converting the surface light image data into photon density just inside the surface of the mammal.

9. (Original) The method of claim 8 wherein there is a linear relation between the light source emission strength in a given volume element and the photon density just inside a surface element.

10. (Original) The method of claim 5 further comprising defining a cost function and a set of constraints for obtaining a solution for the three-dimensional representation of the light source distribution.

11. (Previously Presented) The method of claim 10 wherein the cost function is related to a sum of source strengths for each point source in the mammal, and the constraints include the following conditions: (i) that the source strengths be positive definite and (ii) that the resulting photon density at the object surface produced by the distribution of point sources be everywhere less than the measured surface photon density.

12. (Original) The method of claim 11 wherein obtaining the three-dimensional representation maximizes the cost function subject to the constraints.

13. (Original) The method of claim 10 wherein the cost function and constraints are described mathematically by a system of linear equations, and a solution for the three-dimensional representation of the source distribution is obtained using a SIMPLEX method.

14. (Original) The method of claim 10 further comprising including a weighting factor in the cost function that can be varied to produce a set of solutions for the three-dimensional representation of the source distribution.

15. (Original) The method of claim 10 further comprising varying the number of surface elements to produce a set of solutions for the three-dimensional representation of the source distribution.

16. (Original) The method of claim 5 further comprising varying one of a) the number of volume elements, and b) the configuration of volume elements, to produce a set of solutions for the three-dimensional representation of the source distribution.

17. (Original) The method of claim 5 further comprising optimizing the three-dimensional representation of the light source distribution by calculating the surface light emission for each solution and selecting a solution which minimizes a difference between a calculated and measured surface emission.

18. (Original) The method of claim 16 wherein the varying the number of volume elements and varying the configuration of volume elements both comprise adaptive meshing.

19. (Original) The method of claim 18 wherein the adaptive meshing increases the number of volume elements used to describe the three-dimensional representation of the light source.

20. (Original) The method of claim 19 wherein the adaptive meshing removes volume elements having zero light source strength.

21. (Previously Presented) The method of claim 5 wherein the transport of light within the mammal from a given volume element to a given surface element is described by a Green's function.

22. (Original) The method of claim 21 wherein the Green's function is defined as a solution for light diffusion in a homogenous half space having a planar boundary perpendicular to the line connecting the volume element and the surface element.

23. (Previously Presented) The method of claim 21 wherein the mammal interior is approximated to be inhomogeneous.

24. (Original) The method of claim 21 wherein the Green's function is defined in a look-up table.

25. (Original) The method of claim 21 wherein the Green's function is calculated using Monte Carlo simulations or Finite Element Modeling.

26. (Original) The method of claim 1 wherein the light source is comprised of bioluminescent or fluorescent emission.

27. (Original) The method of claim 1 further comprising applying a noise threshold to the surface light image data.

28. (Original) The method of claim 27 wherein the noise threshold is related to one of the peak intensity in the surface light image data and the dynamic range in the surface light image data.

29. (Original) The method of claim 28 wherein the noise threshold is related to the peak intensity in the surface light image data divided by dynamic range in the surface light image data.

30. (Original) The method of claim 27 wherein the surface representation is divided into a set of surface elements and all surface elements having surface emission below the noise threshold are removed.

31. (Previously Presented) The method of claim 1 wherein the light source emits light that passes through mammal tissue.

32. (Original) The method of claim 31 wherein the animal tissue is approximated to be homogenous.

33. (Previously Presented) The method of claim 1 wherein the mammal has a complex boundary.

34. (Original) The method of claim 1 further comprising producing multiple possible three-dimensional representations of the light source and the three-dimensional representation of the light source obtained is the representation that best fits the measured surface light image data.

35. (Previously Presented) The method of claim 1 further comprising placing the mammal on a stage included in an imaging chamber coupled to a camera configured to capture an image of the mammal on the stage.

36. (Previously Presented) The method of claim 34 further comprising:

moving the stage to a first position in the imaging chamber; and

capturing a first image set of the mammal from the first position using the camera.

37. (Original) The method of claim 35 wherein the first image set is comprised of a luminescent image, a structured light image, and a photographic image.

38. (Previously Presented) The method of claim 34 further comprising:

moving the stage to one or more other positions in the imaging chamber, wherein the other positions have different angles relative to a fixed datum associated with the camera than the first position; and

capturing additional image sets of the mammal from the other positions using the camera.

39. (Previously Presented) The method of claim 38 wherein obtaining the surface representation comprises building a topographic representation of the mammal based on structured light data included in one or more structured light images.

40. (Currently Amended) The method of claim 34 wherein the surface light image data is obtained at ~~**one or more**~~ **a plurality of** different wavelengths.

41-52. (Canceled)

REMARKS

Claims 1 and 3-40 are pending in the present application. Claims 1 and 3-40 have been rejected. No claim has been allowed. Claims 1 and 40 have been amended herein only to correct obvious errors with respect to that which is being claimed. No claims have been canceled. No new claims have been added.

The Final Office Action mailed May 7, 2009 has been carefully considered by Applicants. Reconsideration in view of the foregoing amendments and following remarks is respectfully requested.

I. Interview Summary

The Examiners are hereby acknowledged and thanked for the courtesy extended during the telephonic interview of July 21, 2009 between Examiner Vani Gupta, Examiner Long Le and the undersigned attorney. The Final Office Action, recited prior art and pending claims were all discussed, with particular emphasis on claims 1, 21 and 40, as well as that which is taught by U.S. Patent Nos. 5,865,754 to Sevick-Muraca et al. ("Sevick-Muraca") and 5,867,250 to Baron ("Baron I"). In addition, the Examiner introduced a new prior art reference, U.S. Patent No. 4,761,071 to Baron ("Baron II"). Agreement was not reached with respect to the patentability of any claim. Suggestions were made with respect to various claim amendments, and such claim amendments have been made herein.

II. Rejections Under 35 U.S.C. § 103

Claims 1 and 3-40 all stand rejected under 35 U.S.C. §103(a) as being obvious. Claims 1, 3, 4 and 26-34 are rejected over Sevick-Muraca in view of Baron I. Claims 5-10, 16-20 and 35-40 are rejected over Sevick-Muraca in view of Baron I, in further view of U.S. Patent No. 6,615,063 to Ntziachristos et al. ("Ntziachristos"). Claims, 11-15 and 21-25 are rejected over

Sevick-Muraca in view of Baron I, in further view of Ntziachristos, even further in view of U.S. Patent No. 7,263,157 to Bruder et al. ("Bruder"). In particular, the Final Office Action states, "Sevick-Muraca discloses . . . (a) obtaining a topographical surface representation," also asserts, "Baron [I] establishes relationship between the topographical surface representation and surface light emission data (col. 5, lines 5-27)," and then also states, "[I]t would have been prima facie obvious to modify Sevick-Muraca with Baron to include a establishing a relationship between a surface topography and light emission data of a mammal." Applicants respectfully traverse.

In order for a proffered combination of references to render a claim as obvious, the combination of references must teach or reasonably suggest every material limitation of the claim. Claim 1 recites, *inter alia*, "obtaining a topographical surface representation of the mammal." Each mammal has a different topography and thus a different three-dimensional topographical surface representation. On the other hand, Sevick-Muraca teaches the use of a reference having a constant surface, namely a circular tissue phantom (see, *e.g.*, FIG. 3; col. 7, lines 49-50). A tissue phantom refers to a plastic imaging test device that remains the *same* for all tests. It is used for simplified testing, where the surface of the subject is the same and remains constant for all tests, as taught in Sevick-Muraca. Applicants respectfully submit that the response to this point at page 7 of the Final Office Action misapplies that which is taught by Sevick-Muraca to the claim element at issue. The "embedded heterogeneity" 302 of Sevick-Muraca does not suggest or require "obtaining a topographical surface representation of the mammal," which surface representation of the mammal corresponds to the outer circumference of phantom background 303, and has little to do with the details of embedded heterogeneity 302. Thus, Sevick-Muraca does not obtain "a topographical surface representation of the mammal" as recited in Claim 1. Accordingly, the pending §103 rejection of claim 1 fails for at least this reason.

In addition, the Final Office Action is incorrect in stating that Baron I establishes any relationship between the topographical surface representation and surface light emission data. In

fact, Baron I is directed at optically mapping front and back surface topographies of an object. A careful read of the referenced passage of Baron I (*i.e.*, col. 5, lines 5-27) finds no support for this assertion. Considering the reference as a whole, Applicants respectfully submit that Baron I does *not* establish any relationship between a topographical surface representation and surface light emission data for a light source distribution located inside a mammal. Accordingly, the pending §103 rejection of claim 1 fails for at least this separate and additional reason.

Still further, the Final Office Action improperly assumes that there is any reason to modify Sevick-Muraca in the manner contemplated to arrive at the pending claims, much less that it is obvious to do so by combining Baron I or any other topography reference therewith. Sevick-Muraca teaches the use of a *two-dimensional* reference circle having a constant surface, such as that which is shown in FIG. 3 and described as a circular tissue phantom (Col. 7, lines 49-50). Sevick-Muraca simply does not deal with varying surface representations, much less varying three-dimensional surface representations. As such, Sevick-Muraca has no reason to "reconstruct[] a three-dimensional representation of the light source distribution internal to the mammal *using [a] topographical surface representation* and the surface light emission data," as recited in Claim 1. One of skill in the art would have no reason in the first place to combine any reference with Sevick-Muraca for such a purpose. The proffered combination of references is thus improper as an initial matter. Such a conclusion is inevitable regardless of whether Baron I or Baron II is combined with Sevick-Muraca. Accordingly, the pending §103 rejection of claim 1 fails for at least this separate and additional reason.

Applicants respectfully submit that the §103 rejection of claim 1 fails for at least the foregoing reasons. Because all other claims depend from claim 1, the §103 rejections of all other claims fail for at least the same reasons. Accordingly, Applicants respectfully request the withdrawal of the §103 rejections of all claims.

Dependent Claims

Each of claims 3-40 depends from independent claim 1. As such, it is respectfully submitted that all of these claims are allowable at least on a dependent claim basis from an allowable independent claim.

Furthermore, it is respectfully submitted that various dependent claims are also allowable over the prior art of record for additional reasons. For example, no specific bases are provided as to how the added limitations of any of claims 3, 4, and 26-34 are met by the proffered combination of Sevick-Muraca and Baron I. Accordingly, no *prima facie* basis for rejection has been provided for at least claims 3, 4, and 26-34. The rejections of other dependent claims have similarly been made with scant description as to how the recited prior art teaches or suggests the added limitations of these claims. For example, claims 6-9, 16-20 and 35-40 are summarily dismissed in such a manner. Applicants respectfully submit that the rejections of these claims are improper for at least this additional reason.

CONCLUSION

Applicants respectfully submit that all claims are in proper form and condition for patentability, and thus request a Notification of Allowance to that effect. It is believed that no fees are due at this time. Should any fee be required for any reason related to this document, however, then the Commissioner is hereby authorized to charge such fee or fees to Deposit Account No. 50-4481, referencing Docket No. XENOP009. The Examiner is respectfully requested to contact the undersigned attorney at the telephone number below with any questions or concerns relating to this document or application.

Respectfully submitted,
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Date: July 24, 2009

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